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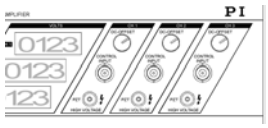
PZ 67E User Manual

E-463 3-Channel HVPZT Amplifier

Release: 1.2.0 Date: 2004-12-07

This document describes the following product(s):

- **E-463.00**
  3-Channel HVPZT Amplifier



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Declaration of Conformity

according to ISO / IEC Guide 22 and EN 45014

Manufacturer:	**Physik Instrumente (PI) GmbH & Co. KG**
Manufacturer´s Address:	Auf der Römerstrasse 1 D-76228 Karlsruhe, Germany

CE

The manufacturer hereby declares that the product

Product Name:	**High-Voltage Amplifier**
Model Numbers:	**E-463.00**
Product Options:	**none**

conforms to the following EMC Standards and normative documents:

Electromagnetic Emission:	EN 61000-6-3, EN 55011
Electromagnetic Immunity:	EN 61000-6-1
Safety (Low Voltage Directive) :	EN 61010-1

August 24, 2004
Karlsruhe, Germany

Dr. Karl Spanner
President

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This manual has been provided for information only and product specifications are subject to change without notice.

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About this Document

Users of this Manual

This manual is designed to help the reader to install and operate the E-463 3-Channel HVPZT Amplifier. It assumes that the reader has a fundamental understanding of basic electronics and applicable safety procedures.
The manual describes the physical specifications and dimensions of the E-463 3-Channel HVPZT Amplifier as well as the procedures which are required to put the associated motion system into operation.
Updated releases are available via FTP or email: contact your Physik Instrumente sales engineer or write info@pi.ws.

Conventions

The notes and symbols used in this manual have the following meanings:

WARNING

Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

DANGER

Indicates the presence of high voltage (> 50 V). Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

CAUTION

Calls attention to a procedure, practice, or condition which, if not correctly performed or adhered to, could result in damage to equipment.

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1 Introduction

E-463.00 HVPZT Amplifiers are bench-top amplifiers for **High-Voltage Piezoelectric Translators** (HVPZTs). The device contains three independent amplifiers capable of outputting and sinking a peak current of 4 mA and an average current of 3 mA each.

One side of the output is grounded, the other ranges from 0 to -1500 V. Negative polarity was chosen to comply with the requirements of common HVPZTs.

The output voltage can be set either manually via a 10-turn potentiometer or by analog control signals, or both in combination. Three 3½-digit LED displays indicate the output voltage of the three channels.

1.1 Safety Precautions

Physik Instrumente (PI) advises you to read this important information:

DANGER

Be aware that the E-463 is a **High Voltage Amplifier** capable of outputting voltages up to **1500 Volts**. The high output power may cause electrical shock or serious injuries if the device is handled improperly.

To avoid danger, follow the instructions below:

Do not open the chassis while the line power cord is connected!

Do not touch any part that may be connected to the high voltage output!

Make sure that the metal casings of all PZT actuators connected to the HV output are properly grounded.

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WARNING

PZTs Sensitive to Overvoltage or Reverse Polarity

Exposing some PZTs to voltages too far outside their operating range will destroy the active element in the actuator. Remember that the active element has only two terminals and is aware only of the potential difference between them. A PZT with -250 V on the negative lead and 0 V on the positive lead sees +250 V. Make sure that both the polarity and the voltage as seen by the PZT are within the allowable range.

1.2 Features

- Manual control mode: 10-turn potentiometer
- External control mode: analog signal, 10-volt-wide range, manual offset
- Real-time output LED display for each channel

1.3 Actuator Types and Terminology

The HV actuators that can be connected to the controller have two conductors for the drive voltage. The displacement of the actuator depends only on the (signed) voltage difference between these two leads. It is important to understand the type of actuator being connected.

1.3.1 Bipolar Actuators

Bipolar actuators can be driven with either a positive or negative potential difference between the drive leads. Because the E-463 can supply only one output polarity, it is not particularly suited for bipolar actuators

1.3.2 Unipolar Actuators

It is important to understand the designations “positive” and “negative” when used with unipolar actuators. These designations refer to the placement (and perhaps the labeling)

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of conductors on the piezo or in the coaxial connecting cable. They originate with the idea that, if one side of the actuator is tied to ground, it is “safer” to have the “dangerous” voltage “farther away” from the user, e.g. in the core of coaxial cable, or not at the end of a stack.

Unipolar piezos can withstand only limited reverse voltages, typically less than 25% of the full operating range. Forward voltage always has the positive terminal at a higher potential than the negative terminal, even if the actuator is referred to as a “negative” type. Since so-called “-1500 V” unipolar actuators were designed with the idea that the positive terminal would be connected to 0 V and the negative terminal range to -1500 V, there is some confusion when it comes to speaking about the voltage “applied to” and “seen by” the actuator. If you put -200 V on the negative terminal and 0 on the positive terminal, you can be tempted to say that you are “applying” “-200 V” to the actuator. For the actuator, however, this is the same as having 0 V on the negative lead and +200 V on the positive lead: in both cases, it sees a +200 V potential difference. Some actuators actually use the labels “0 V” and “-1000 V” on the corresponding leads.

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2 Quick Start

If you order the actuator and controller together, and/or provide PI with sufficient information about your application, the actuator connector will be wired as required.

If you are connecting other actuators or wiring your own connector, read the discussion of actuator type (Section 1.3) carefully and any documentation that came with the actuator.

WARNING

PZTs Sensitive to Overvoltage or Reverse Polarity

Exposing some PZTs to voltages too far outside their operating range will destroy the active element in the actuator. Remember that the active element has only two terminals and is aware only of the potential difference between them. A PZT with -250 V on the negative lead and 0 V on the positive lead sees +250 V. Make sure that both the polarity and the voltage as seen by the PZT are within the allowable range.

DANGER

Be aware that the E-463 is a High Voltage Amplifier capable of outputing voltages up to 1500 Volts. The high output power may cause electrical shock or serious injuries if the device is handled improperly.

To avoid danger, follow the instructions below:

Do not open the chassis while the line power cord is connected!

Do not touch any part that may be connected to the high voltage output!

Make sure that the metal casings of all PZT actuators connected to the HV output are properly grounded.

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First check the unit in manual operating mode as follows:

1 Read the Danger Warning above. Perform the following steps with care.

2 Being careful not to exceed allowable force limits, mount the PZT actuators for your application (see the PZT Mounting Guidelines included with the actuators on a separate sheet)

3 Make sure the E-463 power supply is set to allow operation at the proper voltage range. Two ranges are available: from 100 to120 V and from 220 to240 VAC. The line fuses need to be replaced when the supply voltage range setting is changed (see p. 10 for details).

4 Turn the DC-OFFSET potentiometer to 0, i.e. counter-clockwise (CCW) to the hard stop.

5 With the amplifier still powered down, connect the actuators to the HV output LEMO connectors on the E-463 front panel

6 Connect the line cord and switch the power on.

7 Being careful not to exceed the maximum voltage rating of the connected PZT, turn the corresponding DC-offset potentiometer slowly CW. The voltage changes, as indicated on the corresponding display. The displacement of the PZT depends on its expansion ratio, µm/V.

8 Before turning off the E-463, set all channels to zero output (turn the DC-Offset potentiometers full CCW and make sure the Control IN signals are at 0 V).

The above procedure assures that the system is working correctly in manual mode. If you will be operating with one or more external control signals (static or dynamic), continue as follows:

9 Make sure that the control signal is never below -6.6 V or above +10 V, and varies by at most 10 V.

10 Bring the control signal to its minimum level and connect it to Control IN.

11 Use the corresponding DC-offset potentiometer to adjust the output to the level desired (usually 0 V)

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CAUTION

PZT Damage

Make sure not to exceed the allowed PZT operating voltage!

12 When the control signal is varied (by at most 10 V), the output will change by an amount reflecting the gain factor of -150. Note that this covers a wider range than can be covered in manual operation.

13 Repeat steps 9 to 12 for each channel you wish to connect.

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3 Working Principle

The output voltage is determined by the position of the 10-turn DC-offset potentiometer in combination with the voltage on the Control Input BNC socket.

If Control In is held at 0 V, the output voltage be varied manually with the potentiometer in the range of 0 to -1000 V. This is sometimes called manual operation.

With the DC-offset potentiometer set to 0 (full CCW), the output voltage is controlled by an analog signal applied to the BNC input ranging from 0 to +10 V. Multiplying by the gain factor of -150, an output voltage range from 0 to -1500 V results.

When used together with Control IN, the DC-offset potentiometer effectively allows shifting the 10-volt-wide input voltage range inside the boundaries of -6.66 V and +10 V.

Example 1: A low frequency (< 1 Hz) sinusoidal signal with an amplitude of 0 to +5 V is applied to the CONTROL INPUT socket. The resulting output is a sinusoidal signal with an amplitude of 0 to -750 V.

Example 2: A function generator with a -2.5 to +2.5 V (peak-peak: 5V) sinusoidal signal is connected to the CONTROL INPUT socket. The resulting output will be clipped for negative inputs, because the E-463 can not output positive voltages (negative gain!). The actual output is the negative half of the sine wave with peak value of -375 V (2.5 V multiplied by a gain factor of -150).

In order to get the full sine wave, the input can be offset with the DC-OFFSET potentiometer by 2.5 V. The resulting output is a sinusoidal signal with an amplitude of 0 to -750 V (peak-peak), like in example #1.

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4 Technical Data

Function:	High-voltage DC power amplifier
Application:	Driving up to 3 HVPZTs manually or by external analog signals.
Channels:	3
Output Voltage Range:	0 to -1500 V
Output Polarity:	negative
Peak Current:	4 mA (for < 5 ms)
Max. Average Output Current:	2 mA (for > 5 ms)
Peak power:	6 W (for < 5 ms)
Max. Average Power:	3 W (for > 5 ms)
Control Voltage Input:	10-volt maximum variation within -6.6 to +10 V range
Voltage Gain:	-150 ±1
Input Impedance:	1 M-ohm
Display:	3 3½-digit LED displays
Control input sockets:	3 BNC
PZT output sockets:	3 LEMO ERA.0S.250.CTL
Line Voltage:	110 - 120 or 220 - 240 VAC, selectable (fuse change required)
Fuse:	0.8 A for 230 V operation, 1.6 A for 115 V operation, slow blow fuses required
Dimensions:	288 x 235 x 103 mm (HxWxD)
Weight:	4.3 kg
Operating Temperature	+5°C to +50°C (over 40°C, max. av. power derated 10%)

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4.1 Front Panel Operating Elements

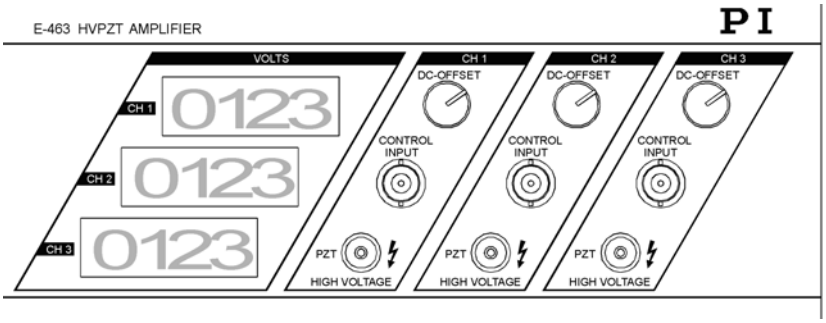

Fig. 1: E-463 Front panel layout

- 3 DC-Offset Potentiometers, 10-turn, one for each channel
- 3 Control voltage Input sockets (BNC), one for each channel
- 3 High-voltage output sockets (LEMO, 0 to 1500V) one for each channel
- 3 3½-digit LED display for output voltages

4.2 Rear Panel

The rear panel contains only the line power connection, voltage range selector, off-on rocker switch and the line fuse assembly.

4.2.1 Voltage Selector

Two ranges are available (220-240 V or 110-120 V). Units are delivered set to the range PI believes prevalent in your country, unless otherwise requested. Selected value is visible in window (see figures). To change selection, pry out and re-orient fuse carrier. Fuses will also need to be replaced.

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4.2.2 Fuses

Fuses are voltage dependent: use 0.8 A* for 230 V and 1.6 A* for 115 V.

Fuse carrier

Door with window

Line cord connector

Fuse carrier

Fig. 2: Voltage selection and fuse access

* slow blow fuses required

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5 E-463 Frequency Response

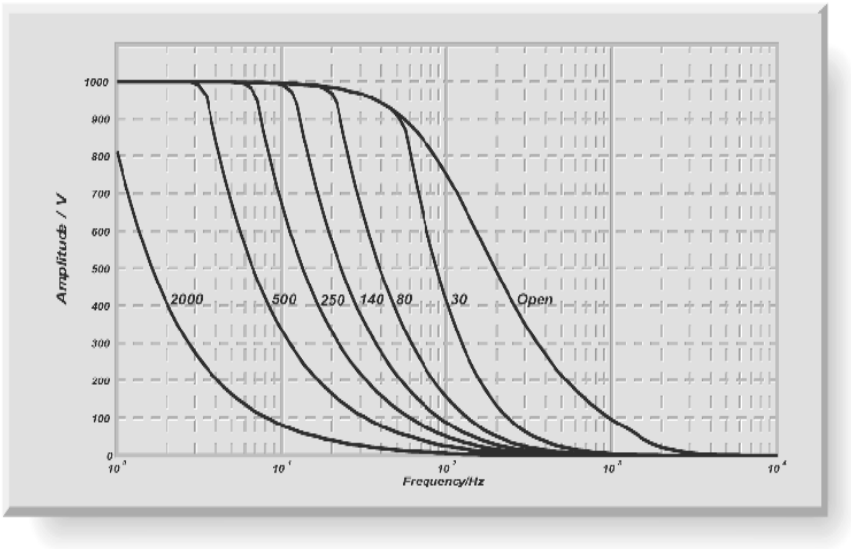

Fig. 3: E-463, frequency response with various PZT loads. Values shown are capacitance in nF, measured in actual PZT.

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